Educational Outcomes of Innovative versus Conventional Medical Curricula: a Review

Dr. H.G. Schmidt

De heer Schmidt is werkzaam bij de vakgroep Onderwijsontwikkeling en Onderwijsresearch van de Rijksuniversiteit Limburg.

Op verzoek van de redactie bewerkte Schmidt een artikel van zijn hand dat binnenkort in het Amerikaanse Journal of Medical Education zal verschijnen. Het bevat een overzicht van een vijftiental onderzoekingen die gedaan zijn naar uitkomsten van probleemgestuurd medisch onderwijs, vergeleken met conventioneel onderwijs. Vergelijkend onderzoek op curriculumniveau naar effecten van verschillende onderwijsbenaderingen is in het hoger onderwijs nog een betrekkelijk nieuw fenomeen, al valt te verwachten dat de behoefte daaraan zal groeien, nu in een tijd van bezuinigingen de vraag naar de kwaliteit van opleidingen aan de universiteiten en in het hoger beroepsonderwijs vaker dan voorheen gesteld wordt.

This article reviews fifteen studies which compare various educational outcomes of problem-based, community-oriented medical curricula with those of conventional programs. The data suggest that problem-based schools provide a student-centered learning environment, encouraging an inquisitive style of learning in their students, as opposed to the learning strategies induced by conventional medical education. In addition, community-oriented schools appear to have an influence on the career preferences of their students. The few data available show that significantly larger proportions of graduates from these schools seek a career in primary care. Some of the studies reviewed suggest that students in conventional programs perform somewhat better on traditional measures of academic achievement as compared to students in problem-based curricula. However, differences, if any, tend to be very small. Data with respect to performance on instruments measuring clinical competence tend to be inconclusive, although students from problem-based schools show marginally better performance.
Finally, the review discusses the many difficulties involved in carrying out comparative research at the curriculum level.

According to an influential report, recently published by the Association of American Medical Colleges (AAMC), medical education, if it is to remain responsive to the needs of society, requires a drastic change. The contents of medical curricula should better adapt to the dramatic growth in the number of individuals with chronic disease, to the increase of the elderly population, and to the roles played by environmental factors and life-styles in the determination of health and illness. More emphasis should be put on the physician's responsibility to work with both individual patients ánd communities to promote health and prevent disease. In addition, basic science teaching and clinical education should be integrated whenever appropriate and the development of skills, values and attitudes should be emphasized at least to the same extent as the acquisition of

knowledge. Furthermore, it is suggested that medical schools should offer educational experiences that require students to be active, independent learners and problem solvers, rather than passive recipients of information, which, according to the Report, will require alterations in the kind of instructional procedures used (Muller, 1984).

A number of medical curricula in the world already have implemented changes like the ones recommended by this report. In fact, the publication of the report was to some extent motivated by experiences of some of these schools, notably those of McMaster University Faculty of Health Sciences in Canada (Neufeld & Barrows, 1974). An important question however, is whether curricular changes of the type exemplified by the AAMC-Report produce improvements in the quality of medical education, and more in particular, to what extent graduates from the new schools are 'better' physicians than those from the traditional schools.

The purpose of this article is to review a number of studies which have attempted to compare the results of medical schools with an innovative program with those of conventional curricula. The review will concentrate on studies concerning the educational outcomes of the curricula of an international group of medical schools known as the 'Network of Community-oriented Educations Institutions for the Health Sciences'. This Network consists of 30 schools, from industrialized as well as developing countries. The more well-known include the medical faculties of the University of New Mexico in the United States, the University of Limburg in the Netherlands, McMaster University in Canada, Suez Canal University in Egypt and the University of Newcastle, Australia (Greep & Schmidt, 1984).

In the next sections, data will be presented on five attributes of interest: academic achievement, clinical competence, career preferences, student perceptions of their educational environment, and learning styles. These attributes have been selected because they encompass the areas in which differences are to be expected between conventional and innovative curricula.

Academic Achievement

One of the impliciet assumptions underlying the structure of many medical curricula is, that students have a limited amount of time available to study what is traditionally defined as the 'core' content of medicine. Consequently, if emphasis is put upon topics or activities not considered to be part of this core, for instance on community medicine or prevention, the amount of attention that could be spent on core content can be expected to decrease, causing a drop of achievement on these topics. The studies addressed in this section try to deal with the question of whether curricular changes of the kind described herein can be considered to be associated with a decrease in academic achievement.

Perhaps the most exhaustive attempts to compare the academic achievement of students in an problem-based school to those in conventional medical education have been made by a group of investigators at the Maastricht medical school of the University of Limburg, the Netherlands, in close collaboration with investigators from other medical schools in the country (Verwijnen, et. al., 1982; Verwijnen, Van der Vleuten and Imbos, in press). All Dutch medical schools have a six year curriculum and similar admission procedures. However, unlike other schools, the Maastricht medical school utilizes problem-based, self-directed learning and community-oriented educational objectives.

In order to compare academic achievement in different schools, Verwijnen and his collaborators employed an instrument measuring academic achievement, called the progress test. This achievement test consists of about 250 true-false items, representing medicine as a whole, selected in a stratified random fashion from a large item bank. Different, but psychometrically equivalent, versions of this test are administered four times a year to all

six year groups of Maastricht medical students for the purpose of assessment and remediation. This test allows for assessing differences between individual students, between different classes within a school and even between different curricula. In one investigation (Verwijnen, et al., in press), the achievement of the six classes of Maastricht medical students on this test was compared with that of other medical schools in the Netherlands. The Maastricht group contained the whole population of 565 students. Two other schools supplied 1067 volunteers, with a third school allowing the investigators to draw a random sample of 167 students. As could be expected, growth in medical knowledge over the years is gradual, although one of the conventional schools showed significantly less progress than the other schools in its second year and more progress in its fourth year. Although some statistically significant differences between schools showed up at certain points in time, these differences tended to be small and non-systematic. The achievement scores of the Maastricht students were somewhat lower than those of two of the other schools at three measuring points, but by the sixth year these differences had disappeared.

Equivalent results have been found by Baca, Mennin, Kaufman and Moore-West (in press), while comparing the performance of different groups of medical students from the University of New Mexico at the National Board of Medical Examiners (NBME). The University of New Mexico Medical Faculty runs two separate but parallel tracks: a conventional and a problem-based program, so comparisons are relatively easy to make. According to Baca and her associates, experimental track students tend to score slightly lower on the comprehensive basic science examination, given at the end of the second year, than students of the conventional track, but the scores on the clinical science examination, given during the fourth year, are similar.

Saunders, et al (in press) administered an 80-item multiple choice test to final year students at the University of Sydney in Australia and a comparable group of students at the University of Newcastle, the latter having the same characteristics as the other problem-based schools discussed here. The questions were largely confined to internal medicine. Two hundred and fourty-three University of Sydney students and 45 University of Newcastle students participated in the experiment (a participation rate of more than 90 percent for both schools). The difference in achievement between the two schools on the test was very small (though statistically significant): Sydney 71 percent correct, Newcastle 67 percent correct.

For more than ten years, Woodward (1984) monitored the achievement of McMaster University graduates in comparison with those of all the other medical schools in Canada on the Medical Counsil Qualifying Examination. Her data shows that on the average, McMaster graduates score slightly below the national average on the multiple choice part of the examination, although results vary from time to time.

The studies reviewed here seem to indicate that, in some cases, students from problem-based programs slightly underachieve on traditional measures of medical knowledge when compared with their colleagues of conventional schools, but differences, if any, are marginal.

Clinical competence and internship performance

The ability to care for patients and solve their problems is taken by many to be the major objective of medical education. The acquisition of knowledge is, in this view, only useful to the extent that it facilitates medical problem-solving. A major proponent of this perspective puts it this way: 'Doctors with encyclopedic information are useless, if not unsafe, if they do not have the problem-solving skills necessary to accurately and efficiently use that information in the care of their patients.' (Barrows, 1984, p. 20). If the acquisition of clinical competence is a vital objective of the innovation, the extent to which students from these problem-based

schools master this skill in comparison to students from conventional medical education, becomes an important question. Data available on this topic are limited however, possibly of disagreement on the issues of what to measure and how to measure the construct of clinical competence.

A study was carried out by Saunders and his associates (in press) on a group of Sydney and Newcastle final year students. These students were presented with two Modified Essay Questions, which were intended to measure clinical competence. No differences emerged, although Newcastle students performed slightly better when items were marked pass-fail, as opposed to ordinal differences between students.

Woodward (1984) however, found that McMaster graduates consistently score above national average on the patient management part of the Medical Counsil Qualifying Examination.

In another study, using reports from supervisors on the performance of these graduates in the first postgraduate year, Woodward and McAuley (1983) were able to show that 25 percent of the McMaster graduates were judged as performing much better than the average fellow intern from other schools, 39 percent as better, 29 percent as about the same and 9 percent as weaker. (284 graduates consented to participate in this study: 77 percent of the total population). However, the comparison group turned out to be somewhat flawed.

Finally, Claessen and Boshuizen (1985) compared the performance of students from the medical schools of the universities of Limburg and Utrecht in the Netherlands on a problem-solving-like cognitive task. Their subjects included small samples of second, third, fourth and fifth year medical students. The subjects were presented with two cases, each consisting of about 50 cards. Each card contained one piece of information about the patient. The subjects were asked to go through the sets of card, reading each card aloud. Subsequently, they were asked to recall as much of the patient information as possible. The amount and the quality of information recalled is generally seen as a sensitive measure of differences in the cognitive structures underlying problem-solving (Patel & Groen, 1986). Taken together, the students of the problem-based school were able to recall more information. These data suggest that these students have cognitive structures available that enable them to process patient data in a somewhat better fashion than students of the more conventional school. Claessen and Boshuizen appear to attribute this phenomenon to the earlier confrontation with patient problems taking place in the problem-based curriculum.

In conclusion, there is weak evidence that students from problem-based programs perform somewhat better on tasks related to clinical competence, but this evidence is limited in scope. The differences, if any, are significant, perhaps with the exception of some of the data provided by Woodward and McAuley (1983).

Career preference and career choice

The career preferences of medical students tend to be quite stable in the course of their curriculum. If there is any change between the moment of enrollment and graduation it tends to be a shift from a preference for primary care to non-primary care specialties (Glasser, Sarnowski & Sheth, 1982; Rothman, 1985). This state of affairs presents a challenge for the community-oriented schools, because their goal is to produce doctors with an awareness of the importance of primary care for the well-being of the population at large. Do they succeed in influencing the preference pattern of medical students? Two studies address the impact of the new curricula on the career preferences of their students.

The first has been carried out at the universities of Kuopio and Tampere in Finland, two relatively new medical schools. Isokoski et al. (in press) investigated the type of medical practice for all physicians registered in Finland between 1978 en 1982. A total of 2917 physicians were registered during that period. Utilizing the register of the Finnish

Medical Association, data concerning the school of graduation were obtained for 93.4 percent of the physicians. Information about the nature of the practice (primary care, hospital-based service, other) was gathered by means of a questionnaire, returned with a response rate of 78 percent. Subsequently, Isokoski and his colleagues computed for each medical school, for five consecutive years, a ratio between the observed frequency of choosing a career in primary care and an expected frequency under the assumption that each medical school graduated the same proportion of physicians pursuing a career in primary care. Their data show that, on the whole, a significantly larger proportion of graduates from the two new schools sought a future in one of Finlands primary care health centres. Their report unfortunately does not contain information about the (regional) manpower needs during the study period. Thus it is impossible to assess the extent to which the career choice pattern resulted from geguine curricular influences or from geographical limitations as to the type of positions available during that period. In addition, it is unclear to what extent students enrolling in the new and the old schools differ in their career preferences from the start.

Research carried out at the University of New Mexico School however, suggests that the structure and aims of a curriculum may indeed influence the professional preferences of its students. Upon entering medical school, students of both the experimental and the conventional track express preference for primary care specialties to the same extent. By graduation, the students in the experimental track were shown to retain their initial interest in family medicine, whereas their conventional track colleagues to some extent have changed their career preferences toward internal medicine. According to Baca et al. (in press) this difference emerges because students in the experimental curriculum had substantially more role modeling in primary care, family medicine and rural practice.

Perceptions of students of their curriculum

The way students perceive the content of the curriculum and the instructional philosophy underlying it, may have an influence on their emotional well-being and motivation to learn. Medical faculties clearly differ in their responsiveness to these needs of students. At the University of New Mexico for instance, experimental track students perceive their learning environment as definitively more flexible, more meaningful, encouraging student interaction and having a better emotional climate than the students of the conventional track (Baca et al., in press).

Many medical schools do not appear to be ideal environments for the fostering of motivated learning. Bender (1979) asked a sample of more than 300 medical students from a large Dutch university to state their opinion about the quality of the (preclinical) instruction they received. The predominant evaluative responses were 'dull', 'tough', 'irrelevant' and 'hardly adapted to the needs of practice'. Schmidt and Moust (1981) replicated Bender's study at the University of Limburg. They asked 45 randomly selected students to write a short essay on their experiences in medical school. Subsequently, they extracted all positive and negative evaluative remarks from these essays. Of 147 evaluative comments, 117 evaluations (that is 80 percent) turned out to be positive for the problem-based program. Many of these remarks had to do with early exposure to health care practice as fostered by the school; on small-group tutorials and on self-directed learning. Negative judgments pertained to the student assessment system and, surprisingly, to small group tutorals. These data partly corroborate the findings of Woodward and Ferrier (1982) who asked graduated classes to describe the strengths and weakness of the McMaster program. They mentioned, in order of importance: 1. problem-based learning, 2. electives, 3. self-directed learning, 4. independent study, and 5. small-group tutorials. Student assessment and clinical skills teaching were considered weaknesses.

An interesting comparative study of perceived strengths and weaknesses in the content of various curricula has been done by Post and Drop (in press). They were interested in the question whether differences could be found in the perceptions of graduates of different medical schools with respect to the amount of emphasis put on various subjects in the medical curriculum. In order to investigate this question, they administered a 45-item questionnaire to all 1982-1984 graduates of the University of Limburg medical school and the 1983 graduates of all other medical schools in the Netherlands. Subjects were asked to indicate their perception of the amount of attention given in a particular subject on a 5-point scale ranging from 'too much' to 'too little'. Response was reasonably high for the Maastricht graduates, but rather low for those from other schools (65 versus 38 percent respectively; the number of forms returned by the graduates from the other schools – 498 – and the homogeneity of their responses however, make some conclusions possible). Differences in knowledge and skills were perceived as largest in the area's of primary care, mental health, multidisciplinary cooperation, human behavior, social skills, preparation for post graduate education and ethical issues. These topics were rated as having been given less attention by the conventional schools. Hospital-based medicine and biomedical science were the subjects that received less emphasis in the new school as compared with conventional education. It should be noticed however, that some graduates from the conventional schools felt that too much attention has been given to biomedical science and hospital-based medicine.

Learning styles

Recently, considerable emphasis has been put on research into the ways university students process information. According to Marton, Hounsell and Entwistle (1984), students appear to develop a preferred 'style' of studying. These different styles or approaches to learning show (moderate) correlations with achievement. Individual students have been observed to favor one of three different broad approaches to the study of subject-matter: a 'surface', a 'deep-level', or a 'strategic' approach. The surface level is largely characterized by a rote learning tendency, aimed at a literal reproduction of the material, and the use of extensive memorization procedures. Students using a deep level approach attempt to integrate what they learn with that they already know, aim at understanding the 'message' underlying a text and look for explanations rather than facts. The strategic mode is descriptive of the behavior of those who try to be successful in higher education with a minimum amount of effort. They do only what is required by a course and their depth of understanding of the subject-matter is largely based on the amount of external pressure provided by the instructor.

In part, these approaches to learning are embedded in personality traits of the students, but they also may be influenced by the educational context or mode of instruction. An example, relevant to the purpose of this article, is provided by Newble and Clarke (in press). They administered the 'Lancaster Approaches to Studying Inventory' (a 64-item questionnaire designed to measure these three modes of learning) to first year, third year and final year medical students of the universities of Adelaide and Newcastle in Australia, the latter being the problem-based school. Their results indicate that fairly large differences exist between the learning approaches that students from these two institutions employ and that these differences already exist by the end of the first curriculum year. Newcastle students rate themselves as having an orientation towards the pursuit of meaning in the material they learn: they utilize a deep level approach, they are low on the reproduction tendency and study less with the strategic goal in mind just to pass the examination, while Adelaide students show a reverse tendency.

Of course, several explanations, other than the causal influence of the different educational environments involved, are possible. Because a self-rating scale was used, the

results might not so much mirror actual differences in study approach, but might be attributed to social desirability ('everybody wants to be considered a deep level processor'). If this is the case however, it is difficult to understand why Adelaide students were less inclined to give socially desirable answers.

Another alternative explanation would be to ascribe the outcomes to specific characteristics of the populations studied. The groups compared may have been different from the start because of different admission procedures. Indeed, the Newcastle school admits students in part based on previous academic achievement, but also takes into account non-academic previous experiences and personality characteristics. However, this explanation is unlikely, because Coles (1985) has found the same effect in two quite different populations: first year students of the Universities of Southampton and Limburg. In addition, Coles showed that these differences do not so much exist upon entry to medical school, but that the educational environment provided by the conventional school appears to induce a surface memorization approach in its students and actually discourages the use of a deep level processing strategy. One may agree with Newble and Clarke (in press) who state that: 'The attributes for which we would hope in a university graduate are very much those embodied in the deep approach. Disturbingly, the (.....) evidence we have, suggests that not only these attributes are unlikely to be achieved by some students but they might be actively inhibited from doing so by our curriculum structures and our teaching and examining methods.'

Discussion

The studies reviewed in this contribution illustrate how difficult it is to compare, at the curriculum level, the effects of different educational approaches on the learning and attitudes of students. Two fundamental problems are involved. First, the subjects, whose behavior is to be compared, are generally not randomly assigned to the treatments, so a major requirement for 'true' experimental comparisons cannot be met. At best, comparisons of this kind can be considered 'quasi-experimental' (Cook & Campbell, 1979). Second, the period over which the treatments are supposed to do their work is so extended that it becomes difficult, if not impossible, to control for extraneous variables that might affect the outcomes but are not in itself subject of investigation. In the studies cited these uncontroled or even uncontrollable variables include a) differences in admission procedures that may make the populations to be investigated different from the start (Newble & Clarke, in press: Woodward, 1984), b) differential attrition of students in the course of the program (Verwijnen, et al., in press), c) unforeseen and undocumented changes in a program that affect its outcomes, d) the use of volunteers (Post & Drop, in press; Verwijnen, et al., in press; Woodward & McAuley, 1983), e) difficulty in composing adequate comparison groups, resulting in the tendency to use 'whoever is available', f) low response rates (Woodward & Ferrier, 1982), and in particular, g) differential exposure to the instrument used to measure curriculum effects (Saunders, et al., in press; Verwijnen, et al., in press). For instance, a more detailed assessment of the Saunders study reveals that the students of the problem-based Newcastle curriculum had never encountered multiple choice questions before in their undergraduate course, while the University of Sydney students had no experience with modified essay questions. This differential exposure to these evaluation instruments may explain the marginal differences between both schools.

A further difficulty is that although the curricula involved are described in the same general terminology (they all are considered 'community-oriented' and use problem-based learning in small-group tutorial sessions as their method of instruction, emphasizing self-directed study), in reality relatively large differences among these programs can be observed. In a survey of ten of these schools, Richards (1986) for instance, found

that three of them offered their students hardly any exposure to community-expe-riences, such as making home visits or conducting epidemiological studies in rural areas, and only five utilized problem-based learning as the main instructional approach (although all of them employed it to some extent). So, the generalizibility of some of the results presented may be doubtful.

It will be clear from these considerations that the conclusions below should be looked upon with some caution.

1. Although differences in knowledge gains favoring the conventional medical schools involved are very small or virtually absent, some data have been presented that appear to imply that problem-based schools are not always successful in inducing their students to attain levels of academic achievement comparable to those of conventional medical education. However, one should realize that the problem-based schools have never advanced specific claims with respect to the knowledge to be acquired by their students; their particular expectation was, and is, that their students would excel in clinical competence. Since the data available in this last area are generally inconclusive, the future challenge to these schools might be to show their students to be superior in clinical competence.

2. The new schools were founded in response to the changing health needs of the various societies. It was felt that the advancement of primary care would help in alleviating at least some of the health problems of a majority of the world population. The scarce information available on the career preferences and actual career choices of students from these schools supports the notion that an emphasis on primary care may influence the professional perspectives of students, that is: innovative schools seem to be successful in their attempts to produce physicians with a community orientation.

3. Problem-based programs also seem to be quite successful in providing an environment that is more adapted to the learning needs of medical students than conventional schools generally do. Apparently, problem-based instruction, emphasizing independent, self-directed learning, fosters in students an inquisitive style of learning, as opposed to the learning strategies that characterize students in conventional programs.

References

Baca, E., Mennin, S.P., Kaufman, A. and Moore-West, M. A comparison between a problem-based, community-oriented track and a traditional track within one medical school. In *Innovation in Medical Education; an evaluation of its present status.* T. Khattab, H.G. Schmidt, Z. Nooman and E. Ezzat (Eds.) New York, NY.: Springer Publishing (in press).

Barrows, H.S. A specific, problem-based, self-directed learning method designed to teach medical problem-solving skills, self-learning skills and enhance knowledge retention and recall. In: *Tutorials in problem-based learning.* H.G. Schmidt and M.L. de Volder (Eds.). Assen, the Netherlands: Van Gorcum, 1984.

Bender, W. Kritische momenten in de medische studie: enkele recente onderzoeksgegevens (Critical moments in medical education: some recent data). *Medisch Contact*, *47*, 402-403, 1979.

Claessen, H.F.A. and Boshuizen, H.P.A. Recall of medical information by students and doctors. *Medical Education*, *19*, 61-67, 1985.

Coles, C.R. Differences between conventional and problem-based curricula in their students' approaches to studying. *Medical Education*, *19*, 308-310, 1985.

Cook, T.D. and Campbell, D.T. *Quasi-experimentation*. New York: Rand McNally, 1979.

Glasser, M., Sarnowski, A.A. and Sheth, B. Career choices from medical school to practice: finding from a regional clinical education site. *Journal of Medical Education*, 57, 442-448, 1982.

Greep, J. and Schmidt, H.G. The Network. *World Health Forum*, 18-21, 1984.

Isokoski, M. et al. Innovative curriculum leads young doctors to primary health care. In *Innovation in Medical Education; an evaluation of its present status*. T. Khattab, H.G. Schmidt, Z. Nooman and E. Ezzat (Eds.) New York, N.Y.: Springer Publishing (in press).

Marton, F., Hounsell, D.J. and Entwistle, N.J. (Eds.) *The experience of learning.* Edinburgh, United Kingdom: Scottish Academic Press, 1984.

Muller, S. (Chairman). *Physicians for the twenty-first century.* Report of the project panel on the general professional education of the physician and college preparation for medicine. *Journal of Medical Education*, *59*, Part 2, November 1984.

Neufeld, V.R. & Barrows, H.S. The 'McMaster philosophy': an approach to medical education. *Journal of Medical Education, 49*, 1040-1050, 1974.

Newble, D.I. and Clarke, R. A comparison of the approaches to learning of students in a traditional and an innovative medical school. *Medical Education* (in press).

Patel, V.L. and Groen, G.J. Knowledge-based solution strategies in medical reasoning. *Cognitive Science*, *10*, 91-116, 1986.

Post, G.J. and Drop, M.J. Perceptions of the content of the medical curriculum at the medical faculty in Maastricht. In: *Innovation in Medical Education; and evaluation of its present status.* T. Khattab, H.G. Schmidt, Z. Nooman and E. Ezzat (Eds.) New York, NY.: Springer Publishing (in press).

Richards, R.W. *But what is a good doctor: progress report of ten innovative medical schools.* Geneva, Switzerland: World Health Organization, 1986.

Rothman, A.I. Statements on career intentions as predictors of career choices. *Journal of Medical Education*, *60*, 511-516, 1985.

Saunders, N.A., et al. A programme of outcome evaluation studies: experiences at the University of Newcastle. In: *Innovation in Medical Education; an evaluation of its present status.* T. Khattab, H.G. Schmidt, Z. Nooman and E. Ezzat (Eds.) New York, NY.: Springer Publishing (in press).

Schmidt, H.G. and Moust, J.H.C. Studiebeleving van Maastrichtse medische studenten (Study perceptions of Maastricht medical students). *Medisch Contact*, *49*, 1515-1518, 1981.

Verwijnen, M., et al. The evaluation system at the Medical School of Maastricht. *Assessment and Evaluation in Higher Education*, *7*, 235-244, 1982.

Verwijnen, G.M., Van der Vleuten, C. and Imbos, T. A comparison of an innovative medical school with traditional schools: an analysis in the cognitive domain. In: *Innovation in Medical Education; an evaluation of its present status.* T. Khattab, H.G. Schmidt, Z. Nooman and E. Ezzat (Eds.) New York, NY.: Springer Publishing (in press).

Woodward, C.A. *Summary of McMaster medical graduates performance on the Medical Council of Canada examination.* Hamilton, Canada: McMaster University, Faculty of Health Sciences, 1984.

Woodward, C.A. and McAuley, R.G. Can the academic background of medical graduates be detected during internship? *Canadian Medical Association Journal*, *129*, 567-569, 1983.

Woodward, C.A. and Ferrier, B.M. Perspectives of graduates two to five years after graduation from a three-year medical school. *Journal of Medical Education*, *57*, 294-303, 1982.